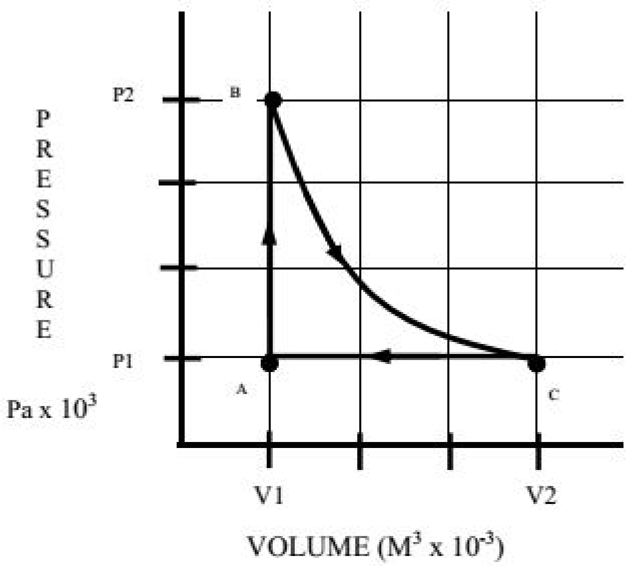
HW 6 PV Diagrams

1. THREE moles of ideal monatomic gas, initially at point A at a pressure of 250×10^3 Newtons per square meter and a volume of 10.0×10^{-3} meter cubed, is taken through a 4-process cycle. There is 15,000 J of net work done (by the system) during one cycle. $C_v = \frac{3}{2}R$ and $C_p = \frac{5}{2}R$ where $R = \frac{8.31J}{(mol*K)}$.



AB

$\triangle U_{ab} = \frac{3}{2}1mol(8.315J/mol/K)(300K) = \boxed{11,000J}$

$W_{ab} = (0m^3)(1,000Pa) = \boxed{0J}$

$Q_{ab} = \boxed{11,000J}$

BC

$\triangle U_{bc} = \frac{3}{2}1mol(8.315J/mol/K)(0K) = \boxed{0J}$

$W_{bc} = 15,000J + (0.03m^3)(250,000Pa) = \boxed{-22,500J}$

$Q_{bc} = \boxed{22,500J}$

CA

$\triangle U_{ca} = \frac{3}{2} 1mol(8.315J/mol/K)(300K) = \boxed{-11,000J}$

$W_{ca} = (0.03m^3)(250,000Pa) = \boxed{7,500J}$

$Q_{ca} = \boxed{-18,500J}$

ACBA

$\triangle U_{abca} = \frac{3}{2} 1mol(8.315J/mol/K)(0K) = \boxed{0J}$

$W_{abca} = \boxed{-15,000J}$

$Q_{abca} = \boxed{15,000J}$

1. Name the processes:

   AB is isochoric
   BC is isothermal
   CA is isobaric

2. How much work is done in process BC?

   Net Work done: -15,000J
   Work done in process CA: $250,000Pa(0.03m^3) = 7,500J$
   Thus, the work done by the environment in process BC is $\boxed{-22,500J}$

3. Is heat added or removed from the system in process BC?

   Heat is added; in process BC, the change in internal energy is zero, and the work done is negative, so Q must be positive.

4. Does this cyclic process represent a heat engine or a heat pump?

   It is a heat engine as heat is put into the system which then does work.

5. What is the ideal efficiency of this process?

Ideal Efficiency: $1 - \frac{T_{min}}{T_{max}} = 1 - \frac{100K}{400K} = \boxed{75\%}$

6. What is the efficiency of this process?

Actual Efficiency: $\frac{|W|}{Q_{in}} = \frac{15,000J}{11,000J + 22,500J} = \boxed{44.776\%}$

Why can't all of the thermal energy in a system be converted into mechanical work done on an environment?

C) The disordered energy in the system cannot be completely converted into ordered energy that can do work.

When a drop of ink enters a glass of water and spreads out, the entropy of the ink-water system

A) It increases.

Describe five everyday examples of processes that involve increases in entropy. Be sure to state all parts of he system and environment involved in these entropy increases.

A wine glass shatters. Some sugar is mixed into coffee. An iron hammer rusts.
Water is splashed out of a pool. Perfume is sprayed out of a bottle.

The entropy of the molecules that form leaves on a tree decreases in the spring of each year. Explain how this is NOT a contradiction of the second law of thermodynamics.

The tree does not exist in a closed system by itself. It uses energy from the Sun to do work and organize itself. In the end, though, entropy has increased because the amount of energy available to do work has decreased in the transition from sunlight energy to glucose energy.